

## REINFORCEMENT OF GLASS SUBSTRATES IN FLEXIBLE DEVICES

### FIELD OF THE INVENTION

[0001] The present invention relates to displays, such as organic light emitting diode (OLED) displays. More particularly, the invention relates to OLED displays, which are compatible for integration in chip cards or other thin flexible applications.

### BACKGROUND OF THE INVENTION

[0002] FIG. 1 shows a conventional OLED device 100. The OLED device comprises one or more organic functional layers 110 between first and second electrodes 105 and 115 formed on a substrate 101. The electrodes can be patterned to form, for example, a plurality of OLED cells to create a pixelated OLED device. Bond pads 150, which are coupled to the first and second electrodes, are provided to enable electrical connections to the OLED cells. A cap 160 is formed over the substrate to encapsulate the device, protecting the OLED cells from the environment such as moisture and/or air.

[0003] The substrate is preferably made from glass due to its good barrier properties against moisture or air. Glass substrates provide other advantages including a smooth surface, temperature and dimensional stability as well as availability of raw materials and processes.

[0004] For flexible applications, such as chip cards, the overall device thickness of the devices need to be less than about 0.6 mm. As such, conventional OLEDs are incompatible since they are too thick and are typically more than 2 mm thick. To reduce the overall thickness and impart mechanical flexibility, thin or ultra thin glass substrates having a thickness of less than 0.4 mm are used. However, the thin glass substrates are fragile and susceptible to breakage due to mechanical stress, such as bending of the chip card.

[0005] As evidenced from the above discussion, it is desirable to provide a thin flexible device formed of a thin glass substrate that is not susceptible to breakage.

### SUMMARY OF THE INVENTION

[0006] The invention relates generally to OLED devices. In particular, the invention relates to the reinforcement and stabilization of displays especially OLED devices on ultra thin substrates, integrated into chip cards and other flexible applications.

[0007] In accordance with the invention, a reinforcement technique is provided for flexible displays. In one embodiment of the invention, a stiff and ductile cover lid is mounted on an ultra thin flexible glass substrate containing OLED devices. The cover lid comprises preferably of metal, or other materials that have higher stiffness and ductility than the substrate to protect it from breakage. The lid and substrate are sealed to encapsulate the OLED devices and protect them from environmental and mechanical damage.

[0008] The thickness of the fabricated OLED display is less than 0.6 mm. It is suitable for integration into chip cards or other thin flexible applications. The reinforcement protects the ultra thin substrates from breakage and does not

affect the flexibility of the substrate. The process is suitable for large area, cost effective mass production.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 shows a conventional OLED device; and

[0010] FIG. 2 shows one embodiment of the invention integrated into a chip card.

[0011] FIG. 3(a) shows the result of bending a smart card containing a conventional display without metal reinforcement.

[0012] FIG. 3(b) shows the result of bending a chip card containing a display with metal reinforcement, according to one embodiment of the invention.

[0013] FIG. 4 shows one embodiment of the invention.

[0014] FIGS. 5-7 show other embodiments of the invention.

### PREFERRED EMBODIMENTS OF THE INVENTION

[0015] The invention relates generally to flexible devices formed on thin substrates. In one embodiment of the invention, a flexible OLED device is formed on a thin glass substrate. In one embodiment of the invention, a stiff and ductile metal cover is mounted on the substrate to reinforce it and prevent it from breaking. The OLED device is particularly useful in thin flexible surfaces, for example, chip cards.

[0016] FIG. 2 shows a fabricated display 400, according to one embodiment of the invention, integrated into a flexible chip card 300. Typically, the chip card has outer dimensions of 86 mm by 54 mm with a thickness of 0.7 mm. For a seven-segment display, for example, the OLED display typically occupies an area of 22 mm by 10 mm. Since the display occupies a small fraction of the entire chip card area, the bending motion applied during a bending test can be restricted to the region not occupied by the display. Hence, the non-display area absorbs the mechanical strain introduced to the card during bending, as shown in FIG. 3(b), and the display remains undamaged. FIG. 3(a) shows the shape of the card that contains a display not reinforced by metal. Without protection from the metal cover, the display will be subjected to mechanical strain that may cause breakage.

[0017] FIG. 4 shows one embodiment of the invention. A thin or ultra thin glass substrate 410 is provided. The glass substrate, for example, can be made from silicate glass such as borosilicate glass. Other transparent materials, such as soda lime glass or other types of glass, are also useful. Typically, the thickness of the thin glass substrate is less than about 0.4 mm, preferably about 0.01-0.2 mm, and more preferably about 0.03-0.2 mm.

[0018] A conductive layer 420 is deposited on the substrate. The conductive layer is then patterned, selectively removing portions thereof as desired. The patterned conductive layer serves as first electrodes for the OLED cells.

[0019] In a preferred embodiment, a dielectric layer 470 is deposited on the substrate after the conductive layer is patterned. The dielectric layer, in one embodiment, comprises a photosensitive layer, such as photosensitive resist or